

MATERIAL SAFETY DATA SHEET

1. SUBSTANCE AND SOURCE IDENTIFICATION

National Institute of Standards and Technology
Standard Reference Materials Program
100 Bureau Drive, Stop 2320
Gaithersburg, Maryland 20899-2320

SRM Number: 3165
MSDS Number: 3165
SRM Name: Vanadium Standard Solution

Date of Issue: 16 May 2006

MSDS Coordinator: Mario J. Cellarosi
Telephone: 301-975-6776
FAX: 301-926-4751
E-mail: SRMMSDS@nist.gov

Emergency Telephone ChemTrec:
1-800-424-9300 (North America)
+1-703-527-3887 (International)

Description: This Standard Reference Material (SRM) is intended for use as a primary calibration standard for the quantitative determination of vanadium. One unit of SRM 3165 consists of five 10 mL sealed borosilicate glass ampoules of an acidified aqueous solution prepared gravimetrically to contain a known mass fraction of vanadium. The solution contains nitric acid at a volume fraction of approximately 10 %.

Material Name: Vanadium Standard Solution

Other Designations:

Vanadium: V; elemental vanadium; vanadium dust

Ammonium Metavanadate: Ammonium trioxovanadate; ammonium vanadate; vanadic acid, ammonium salt; ammonium vanadium oxide; ammonium vanadium trioxide; ammonium monovanadate; hydroxy-dioxo-vanadium.

Nitric Acid: Aqua fortis; hydronitrate; azotic acid; engraver's acid.

2. COMPOSITION AND INFORMATION ON HAZARDOUS INGREDIENTS

Component	CAS Registry	EC Number (EINECS)	Concentration (%)
Nitric Acid	7697-37-2	231-714-2	10
Ammonium Metavanadate	7803-55-6	232-261-3	1.1
Vanadium	7440-62-2	231-171-1	0.5

EC Classification, R/S Phrases: Refer to Section 15, Regulatory Information.

3. HAZARDS IDENTIFICATION

NFPA Ratings (Scale 0-4): Health = 4 Fire = 0 Reactivity = 2

Major Health Hazards: Nitric acid can cause severe or fatal burns if inhaled, swallowed, or absorbed through the skin. Vanadium and its compounds can cause eye irritation, asthma-like symptoms, and other serious effects.

Physical Hazards: None documented for this mixture; glass container may break or shatter.

Potential Health Effects

Inhalation:	Nitric acid, if inhaled, can damage the mucous membranes and respiratory tract, causing spasm, inflammation of the larynx and bronchi, chemical pneumonitis, and pulmonary edema. Symptoms may include burning sensation, coughing, wheezing, laryngitis, shortness of breath, headache, nausea, and vomiting. Inhalation of vanadium dust or ammonium metavanadate can irritate the nose, throat, and upper respiratory tract; effects may include nosebleed, headache, tremors, dizziness, or bronchitis. Vanadium may also cause an allergic reaction, with asthma-like symptoms that recur or become worse with each exposure. Prolonged or high-level exposure to vanadium can cause greenish-black discoloration of the tongue.
Skin Contact:	Nitric acid can cause severe skin burns. Effects of acid burns may be delayed. Contact with vanadium or its compounds can cause skin irritation.
Eye Contact:	Nitric acid can cause severe eye irritation, corneal burns, permanent eye damage, or blindness. Vanadium dust and ammonium metavanadate can cause severe eye irritation with profuse tearing and burning sensation.
Ingestion:	Nitric acid can cause severe burns and damage to the GI tract. Ingestion of vanadium or ammonium metavanadate may cause abdominal pain, nausea, and vomiting. In laboratory animals, prolonged or repeated exposure to vanadium has caused kidney and liver damage, anemia, convulsions, and death, but these effects are unlikely in humans at workplace exposure levels.

Medical Conditions Aggravated by Exposure: The mixture and its components may aggravate pre-existing disorders of the eyes, skin, respiratory tract, blood, or kidneys. Persons who take dietary supplements containing high levels of zinc may be more susceptible than others to the toxic effects of vanadium.

Listed as a Carcinogen/ Potential Carcinogen:

	Yes	No
In the National Toxicology Program (NTP) Report on Carcinogens	_____	<u> X </u>
In the International Agency for Research on Cancer (IARC) Monographs	_____	<u> X </u>
By the Occupational Safety and Health Administration (OSHA)	_____	<u> X </u>

Note: Vanadium pentoxide (V_2O_5) is a known carcinogen.

4. FIRST AID MEASURES

Inhalation: Move the person to fresh air immediately. If not breathing, qualified personnel may start CPR or give oxygen if necessary. Get medical aid at once, and bring the container or label.

Skin Contact: Remove contaminated clothing and shoes. Flush affected skin with water for at least 15 minutes, then wash thoroughly with soap and water. If burns are severe or if skin irritation persists, get medical aid and bring the container or label. Wash contaminated clothing before reusing.

Eye Contact: Remove contact lenses (if any). Do not allow victim to rub eyes or keep eyes closed. Flush eyes with large amounts of running water for at least 30 minutes, keeping eyelids open and raising lids to remove all chemical. Get medical aid at once, and bring the container or label.

Ingestion: Contact a poison control center immediately for instructions. Wash out mouth with water, but do not induce vomiting. Get medical aid at once, and bring the container or label.

Note to Physician (Nitric Acid): Wash affected skin with 5% solution of sodium bicarbonate ($NaHCO_3$). Activated charcoal is of no value. Do not give bicarbonate to neutralize the material.

5. FIRE FIGHTING MEASURES

Fire and Explosion Hazards: No data are available for this mixture, but it is not believed to be a significant fire or explosion hazard. The behavior of the solution may differ from that of the individual components. Nitric acid does not burn, but it is a powerful oxidizing agent that can react with combustible materials to cause fires. Vanadium and ammonium metavanadate are negligible fire hazards when exposed to heat or flames.

Extinguishing Media: Use extinguishing media appropriate to the surrounding fire: water spray, dry chemical, carbon dioxide, or foam. A water spray may be used to cool exposed containers to prevent rupture. (These guidelines apply to the mixture; when the components are considered separately, different precautions may apply.)

Fire Fighting: Avoid inhalation of material or combustion byproducts. Wear full protective clothing and NIOSH-approved self-contained breathing apparatus (SCBA).

Flash Point (°C): N/A

Autoignition (°C): N/A

Lower Explosive Limit (LEL): N/A

Upper Explosive Limit (UEL): N/A

Flammability Class (OSHA): N/A

6. ACCIDENTAL RELEASE MEASURES

Occupational Release: Notify safety personnel of spills. Surfaces contaminated with this material should be covered with soda ash or sodium bicarbonate to neutralize the acid. Place the neutralized material into containers suitable for eventual disposal, reclamation, or destruction.

Disposal: Refer to Section 13, Disposal Considerations.

7. HANDLING AND STORAGE

Storage: Store unopened containers of this material in a dry place at room temperature. Protect from physical damage, heat, and light, and isolate from incompatible materials.

Safe Handling Precautions: Wear gloves and chemical safety goggles (Section 8). Engineering controls should maintain airborne concentrations below TLV (Section 8).

8. EXPOSURE CONTROLS AND PERSONAL PROTECTION

Nitric Acid:

ACGIH TLV-TWA: 2 ppm or 5 mg/m³
OSHA TLV-TWA: 2 ppm or 5 mg/m³

Ammonium Metavanadate:

ACGIH TLV-TWA: 0.05 mg/m³ (respirable dust or fume)
OSHA TLV-TWA: 0.05 mg/m³ (respirable dust), 0.01 mg/m³ (fume)

Vanadium:

ACGIH TLV-TWA: 0.05 mg/m³ (respirable dust or fume)
OSHA TLV-TWA: 0.05 mg/m³ (respirable dust), 0.01 mg/m³ (fume)

Ventilation: Use local or general exhaust to keep employee exposures below limits. Local exhaust ventilation is preferred because it can control contaminant emissions at the source, preventing dispersion into the general work area. Refer to the ACGIH document *Industrial Ventilation, a Manual of Recommended Practices*.

Respirator: If necessary, refer to the NIOSH document *Guide to the Selection and Use of Particulate Respirators Certified under 42 CFR 84* for selection and use of respirators certified by NIOSH.

Eye Protection: Use chemical safety goggles where dusting or splashing of solutions may occur. See OSHA standard (29 CFR 1910.133) or European Standard EN166. The employer should provide an emergency eye wash fountain and safety shower in the immediate work area.

Personal Protection: Wear appropriate gloves and protective clothing to prevent contact with skin.

9. PHYSICAL AND CHEMICAL PROPERTIES

Nitric Acid	Ammonium Metavanadate	Vanadium
Appearance and Odor: Colorless to slightly yellow liquid, darkens to brown upon aging and exposure to light; irritating, pungent odor.	Appearance and Odor: White, colorless, or yellowish hygroscopic powder or crystals; no odor.	Appearance and Odor: Lustrous white or gray powder; no odor.
Relative Molecular Weight: 63.02	Relative Molecular Weight: 116.98	Relative Molecular Weight: 50.94
Molecular Formula: HNO ₃	Molecular Formula: H ₄ NO ₃ V	Molecular Formula: V
Specific Gravity: 1.0543 (10%)	Specific Gravity: 2.33	Specific Gravity: 5.96
Solvent Solubility: Decomposes in alcohol	Solvent Solubility: Soluble in dilute ammonium hydroxide and mono- and diethanolamine; insoluble in ammonium chloride solutions, alcohol, and ether.	Solvent Solubility: Soluble in aqua regia, nitric acid, concentrated sulfuric acid, and hydrofluoric acid.
Water Solubility: Soluble	Water Solubility: Slightly soluble	Water Solubility: Insoluble
Boiling Point (°C): 86 (187°F)	Boiling Point (°C): N/A	Boiling Point (°C): 3407 (6165°F)
Vapor Pressure (Pa): 946 @20°C	Vapor Pressure (Pa): N/A	Vapor Pressure (Pa): Negligible
Vapor Density (Air=1): 2.17	Vapor Density (Air=1): N/A	Vapor Density (Air=1): N/A
pH: 1.0 (0.1M solution)	pH: N/A	pH: N/A

NOTE: The physical and chemical data provided are for the pure components. No physical or chemical data are available for this solution of vanadium and nitric acid. The actual behavior of the solution may differ from the individual components.

10. STABILITY AND REACTIVITY

Stability: X Stable Unstable

Stable at normal temperatures and pressure.

Conditions to Avoid: Moisture, heat, incompatible materials.

Incompatible Materials:

Nitric Acid: Incompatible with numerous materials including organic materials, plastics, rubber, chlorine, and metal ferrocyanide.

Ammonium Metavanadate: Incompatible with strong acids, strong oxidizing agents.

Vanadium: Incompatible with bromine trifluoride, chlorine, lithium, nitryl fluoride, oxidizers, strong bases.

Fire/Explosion Information: See Section 5.

Hazardous Decomposition: When heated, nitric acid may produce toxic mist or vapor and nitrogen oxides (NO, NO₂, N₂O). Thermal decomposition of vanadium and its compounds may produce toxic fumes of vanadium oxides. Vanadium pentoxide (V₂O₅) is a known carcinogen.

Hazardous Polymerization: ☐ Will Occur ☒ Will Not Occur

11. TOXICOLOGICAL INFORMATION

Route of Entry: ☒ Inhalation ☒ Skin ☒ Ingestion

Nitric Acid:

Human, oral: LD_{Lo} = 430 mg/kg

Rat, oral: LD₅₀ > 90 mg/kg

Rat, inhalation: LC₅₀ (4 hrs) = 130 mg/m³

Ammonium Metavanadate:

Rat, oral: LD₅₀ = 58 mg/kg

Rat, inhalation: LD₅₀ (4 hrs) = 7.8 mg/m³

Vanadium:

Mouse, oral: Very high oral doses (1000 mg/kg) caused gastritis but no deaths.

Rabbit, subcutaneous: LD₅₀ = 59 mg/kg

Target Organ(s): Skin, eyes, respiratory tract, immune system (allergic reaction), GI tract.

Mutagen/Teratogen: Nitric acid has caused birth defects in animals under experimental conditions, and has been investigated as a possible mutagen. Ammonium metavanadate and other vanadium compounds may cause mutations. Dietary vanadium appears to suppress egg production in domestic chickens.

Health Effects: See Section 3.

12. ECOLOGICAL INFORMATION

Nitric Acid, Ecotoxicity Data:

Green shore crab (*Carcinus maenas*): LC₅₀ (48 hrs) = 180,000 µg/L

Starfish (*Asterias rubens*): LC₅₀ (48 hrs) = 100,000 to 330,000 µg/L

Brook trout (*Salvelinus fontinalis*): NR-LETH = 1,562 µg/L

Ammonium Metavanadate, Ecotoxicity Data:

Channelfish (*Nuria danrica*): LC₅₀ (24 hrs) = 13.3 mg/L

Freshwater hydroid (*Cordylophora caspia*): EC₅₀ (10 days) = 5.8 mg/L

Vanadium: When released to water, vanadium is expected to exist mainly in the tetravalent and pentavalent forms. Both forms bind strongly to mineral and biogenic surfaces.

Rainbow trout (*Oncorhynchus mykiss*): LC₅₀ (96 hrs) = 11.4 mg/L

Colorado squawfish (*Ptychocheilus lucius*): LC₅₀ (96 hrs) = 3.8 mg/L

Mussel (*Mytilus galloprovincialis*): LC₅₀ (9 days) = 35 mg/L

Worm (*Nereis versicolor*): LC₅₀ (9 days) = 10 mg/L

Environmental Summary: Some or all components of this mixture are toxic to aquatic organisms. Do not release to the environment.

13. DISPOSAL CONSIDERATIONS

Waste Disposal: One or more components of this mixture are classified as RCRA hazardous waste. Dispose of container and unused contents in accordance with federal, state, and local requirements for acid waste, which vary according to location. Decontaminate containers before recycling. Processing, use, or contamination of this product may change the waste management options.

14. TRANSPORTATION INFORMATION

U.S. DOT and IATA: Nitric Acid Solution; Hazard Class 8, UN2031, Packing Group II

15. REGULATORY INFORMATION

U.S. REGULATIONS

CERCLA Sections 102a/103 (40 CFR 302.4):

Nitric Acid: RQ = 1000 lb.

Ammonium Metavanadate: Not regulated

Vanadium: Not regulated

SARA Title III Section 302: Nitric acid is regulated.

SARA Title III Section 304: Nitric acid is regulated.

SARA Title III Section 313: All three components are regulated (ammonium metavanadate as N770, Vanadium Compounds).

OSHA Process Safety (29 CFR 1910.119): Nitric acid at higher concentrations ($\geq 94.5\%$) is regulated.

SARA Title III Sections 311/312 Hazardous Categories (40 CFR 370.21):

ACUTE: Yes

CHRONIC: Yes

FIRE: No

REACTIVE: Yes

SUDDEN RELEASE: No

STATE REGULATIONS

California Proposition 65: No components are regulated.

CANADIAN REGULATIONS

WHMIS Classification:

Nitric Acid: C (oxidizing material), D1A (very toxic material), E (corrosive material)

Ammonium Metavanadate: D2A (very toxic material)

Vanadium: D2B (toxic material)

WHMIS Ingredient Disclosure List: All three components are regulated.

CEPA Domestic Substances List (DSL): All three components are regulated.

EUROPEAN REGULATIONS

EU/EC Classification:

Nitric Acid: O (Oxidizer), C (Corrosive)

Vanadium and Ammonium Metavanadate: T (Toxic); not classified in Annex I of Directive 67/548/EEC; not on a priority list.

Risk Phrases (mixture):

R23 (toxic by inhalation)
R25 (toxic if swallowed)
R34 (causes burns)
R36/37/38 (irritating to eyes, respiratory system and skin)
R42 (may cause sensitization by inhalation)

Safety Phrases (mixture):

S20/21 (when using, do not eat, drink or smoke)
S28 (wash after contact with skin)
S45 (in case of accident or illness, see doctor; show label)
S60 (dispose of this material and its container as hazardous waste)

NATIONAL INVENTORY STATUS

U.S. Inventory (TSCA): All three components are listed.

TSCA 12(b), Export Notification: No components are listed.

16. OTHER INFORMATION

Sources:

Hazardous Substances Data Bank (HSDB): Vanadium, Elemental.

Hazardous Substances Data Bank (HSDB): Vanadium Compounds.

Hazardous Substances Data Bank (HSDB): Ammonium Metavanadate.

IUCLID Chemical Data Sheet: Vanadium. European Chemicals Bureau, 19 February 2000.

New Jersey Department of Health, Hazardous Substance Fact Sheet: Vanadium (Dust and fume). January 2001.

U.S. National Institute for Occupational Safety and Health, *NIOSH Pocket Guide to Chemical Hazards*, June 1990 edition. DHHS (NIOSH) Publication No. 90-117.

Disclaimer: Physical and chemical data contained in this MSDS are provided only for use as a guide in assessing the hazardous nature of the material. The MSDS was prepared carefully, using current references; however, NIST does not certify the data in the MSDS. The certified values for this material are given in the NIST Certificate of Analysis.